INTRODUCTION

Terms like carbon footprint, life cycle assessment (LCA), carbon label, greenhouse gases (GHGs) and global warming potential (GWP) are more and more present in our lives. They may be used as marketing tools to persuade consumers about the environmental benefits of a product; or as a management tool for producers to estimate the influence of their product or business on global warming.

This leaflet will explain these terms and help you to understand the principles of carbon footprints and what they can tell you.

The Greenhouse Gases effect

The term **greenhouse gas** (GHG) refers to 1% of all atmospheric gases. GHGs act like an insulating blanket trapping parts of the radiation from the sun in the atmosphere, an effect which is called the **greenhouse effect**. Without these gases, it is estimated that the average temperature of the earth would be 33˚C colder than it is – giving Wales an average summer temperature of around minus 17˚C!

Some greenhouse gases occur naturally and are also generated by human activity; others have only been produced as a result of human industrial processes.

As a consequence of increasing emissions from human activity, the GHG concentration in the atmosphere is rising. Precisely what effect this will have on the earth's climate is uncertain. It is thought that the GHGs will trap more radiation, intensifying the greenhouse effect, and resulting in an increase in overall temperature. This is known as **global warming**.

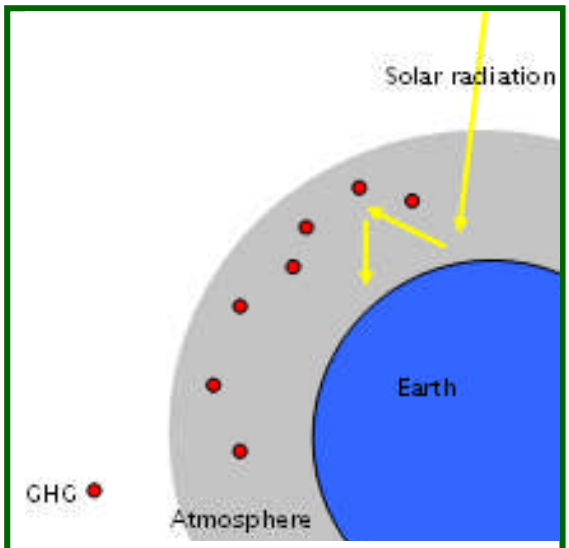

Fig 1: Solar radiation trapped by greenhouse gases (GHGs) in the atmosphere

Greenhouse gases in agriculture and horticulture

The three GHGs most relevant in the agricultural and horticultural sectors are methane, nitrous oxide and carbon dioxide.

Methane (CH_4) is a product of the ruminant digestive system. It is also emitted through anaerobic decaying of organic matter in land fill sites and rice production in paddy fields. It is a component of natural gas. A lot of the methane cycle is still unknown.

Nitrous oxide (N_2O) is the least researched GHG in a global climate change context. It is naturally emitted through microbial action in soils. Application of nitrogenous fertilizer and the Haber-Bosch process (process to synthesise ammonia from hydrogen and nitrogen) are human sources of N_2O.

Carbon dioxide (CO_2) is naturally emitted through volcanoes, forest fires and respiration from plants and creatures. It is also a by-product of several industrial processes (e.g. producing fizzy drinks) and is released when burning fossil (coal, gas, oil) and wood fuel (and forests during clearance).

The other greenhouse gases are: chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). All of these are created through human processes; they did not even exist before the 18th century. Water vapour also acts as a greenhouse gas.

Carbon footprint

Carbon footprint is the name that has been given to the estimated GHG production from a given process. The process could be your lifestyle (the things you consume, the way you travel, the waste you create); or the production of a particular item (e.g. carrots); or of a whole production site (the farm). The name is somewhat

misleading. A carbon footprint does not estimate carbon, but carbon dioxide. Carbon dioxide, as the name suggests, comprises one carbon atom and two oxygen atoms. The carbon, with an atomic weight of 12, represents just over one quarter of the total atomic weight (which is 44). What is more, a carbon footprint also considers all the other GHGs involved. Each GHG has a different impact on global warming, which is described with the term **global warming potential (GWP)**.

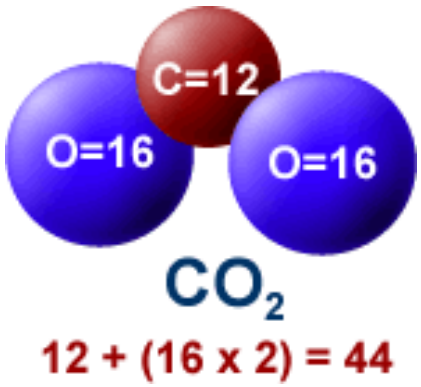

Fig 2: CARBON DIOXIDE MOLECULE
Each molecule of carbon dioxide (CO_2) is made up of one carbon atom (weight = 12) and two oxygen atoms (each with a weight of 16)

Because different gases persist for different lengths of time in the atmosphere, a fixed time period over which to consider their impacts is required. It has become conventional to compare the predicted impacts of the greenhouse gases on global climate by considering a 100 year period. Some scientists think that the 100 year time frame is too long and suggest a shorter period should be used, but, for the time being, it is the 100 year model that is most widely adopted.

Over this time period, scientific models suggest that 1kg of methane will have the same effect on global warming (GWP) as 25kg of carbon dioxide; and 1kg of nitrous oxide approximates to 298kg of carbon dioxide. To simplify the calculations for the carbon footprint, the GWP of each gas is therefore expressed as carbon dioxide equivalents (CO_2e).

At this point in time, there is no European or global standard procedure to calculate a carbon footprint. A considerable amount of research and effort is being put into the development of standards. However, they frequently focus on industrial processes, rather than the biological processes involved in agriculture and horticulture.

In the absence of a standard procedure different assumptions may be used by different calculators. This means that comparing the carbon footprints of different products is difficult, and might be misleading. For example, using refrigerated storage to provide year round supplies of seasonal produce substantially increases the product's true carbon footprint. However, as there is no standardised reporting method, it could be that fresh produce and stored produce will be presented as having similar carbon footprints because the time in storage can be ignored.

Carbon calculators

A range of on-line carbon calculators is now available. On the whole, these have not been developed with the specific requirements and peculiarities of the agricultural and horticultural industries in mind. By putting your own data into some of these calculators, you will begin to see the wide range of results that the same inputs can generate, depending on the underlying assumptions that are driving the model.

Life cycle assessments

A shortcoming of carbon footprinting as a methodology for evaluating environmental impacts of processes is that it does not take into account other important environmental factors. For instance, a product with a low carbon footprint might be deleterious to biodiversity, or water quality, but these negative impacts would not be noticed if only the carbon footprint is considered.

Life Cycle Assessment (LCA) is another environmental evaluation tool. An LCA tries to capture the whole environmental impact of a product from "cradle-to-grave", starting at the initial resources needed to create the product and evaluating the processes all the way through to the products final disposal. Carbon footprints can be part of a **Life Cycle Assessment** (LCA) of a product. Measuring the GWP is only one of the environmental categories for a LCA, amongst others are: toxicity to humans, radiation, land use and habitat loss, and ozone depletion. LCAs are considered as snapshots which will change over time and are only as good as the data which was used to create them.